were not wisely chosen, the facts in the case not being before me, I am free to confess that I have grave doubts whether they were even as well adapted to the purpose as the ordinary dry plates. In any case, the best work on the corona has yet to be done, with plates prepared for that special purpose, and with apparatus specially arranged. Several efforts have been made in this direction abroad, not with entire satisfaction it is true, but they indicate a recognition of progress in photographic work, and a laudable disposition to apply the latest knowledge to special requirements. I am not aware that any photographic experiments are now under way in anticipation of improved methods to be applied to the solar eclipse next year. If not, we have no reason for expecting any better photographs of the corona than those of Professor Holden, which are doubtless as good as can be made without special plates. Let me add as a purely gratuitous opinion, founded, however, upon long consideration of the subject, that I am convinced of the practicability of photographing the corona without waiting for an eclipse. To do this, however, would require no small amount of preliminary work, for which a well-equipped laboratory is necessary.

Not wishing to extend this communication to undue length, I confine my remarks to these few eminently practical subjects for laboratory research, only adding that there are many others which deserve investigation, such as photographic standards of light and color, methods of recording daily solar activity, the comparison of the chemical and visual effect of light of various colors,—a very important subject in stellar photography,— atmospheric absorption, the application of photography to meteorology, the formation of clouds, lightning, and a host of other subjects which will suggest themselves.

The point I wish specially to make is that a photographic research laboratory would be of the greatest value as an aid to research in many branches of physical investigation. It has been my privilege to visit the laboratories of Dr. Eder in Vienna and Dr. Vogel in Berlin, both of which have contributed so much to a practical and scientific knowledge of photographic methods; but above either of these, for purely scientific research, I should say the private laboratory of Mr. Schumann, in Leipzig, although much more restricted in scope, approaches nearer to my ideal of what we most need in this country.

I trust that these few words will receive such favorable consideration and support from the scientific men of the country — especially from those who have experienced the shortcomings of photography in recording the results of their work — as they may seem to deserve, and that a laboratory such as I have indicated may soon be established either in connection with one of our large universities or by private endowment.

The Woodmont, Washington, D. C., Sept. 9.

THE RETICULATED PROTOPLASM OF PELOMYXA.

BY DR. ALFRED C. STOKES.

WITHIN recent years the structure of protoplasm has been much studied by microscopists, and the several theories enunciated have attracted considerable attention and been the subject of considerable discussion. The entire subject is a fascinating one, but among all the doctrines put forth by various observers, either as the result of personal investigations with modern high-power objectives, or as a result of a working of the "scientific imagination," none has received more attention of a certain kind, and none is more pleasing, than Dr. Carl Heitzmann's theory of the reticulation of the protoplasm. Yet simple and beautiful as his doctrine is, it has been ridiculed and summarily dismissed by those that have failed to obtain results similar to his.

Dr. Heitzmann claims that all animal protoplasm is at all times a net-work of delicate threads, in which is the life of the object, the meshes thus formed containing the liquid or semi-liquid and other non-living constituent parts of the protoplasm. His book on the "Microscopical Morphology of the Animal Body in Health and Disease" is somewhat surprising, since he sees all tissues as formed of reticulated protoplasm, an appearance that he seems to have no difficulty in demonstrating, but which the majority of microscopists and histologists claim to be unable to see, and which they say is therefore non-existent. The subject merits further attention. Judging from a limited experience, but from an experience gained through an eye to a certain extent trained in microscopical examination with high powers, I am willing to confess that the Heitzmann doctrine of the structure of protoplasm is more than satisfying; if it should be proved to be illusory or the result of the action of reagents, I should be disposed to abandon it with regret.

In 1873, Dr. Heitzmann, before the Vienna Academy, demonstrated the reticular structure of the protoplasm of the common *Amœba*, a microscopic animal within reach of every microscopist, and one in which the reticulation should be readily seen with the proper optical appliances, if it exist. I do not know that any effort has ever been made in this country to repeat this observation in order to refute or to confirm it. The white corpuscles of human blood are conspicuously reticulated after treatment with certain reagents, and if the common *Amœba* should present a somewhat similar structure without having been subjected to the action of a chemical solution, the fact would be of great importance and interest. It would seem, too, that microscopists are not living up to their privileges if they fail to heed a suggestion that may be of so great importance. Yet so far as any prominent printed record appears, the common *Amœba* has never been examined with modern high-power objectives by competent microscopists having this object in view. If such papers have been published, they have not come to my notice. I am not claiming any merit on my own part, for I am also one of those that have given no attention to this attractive subject. I have never submitted the *Amœba* to the tests needed to demonstrate, for my own personal satisfaction if for no other reason, whether or not the reticulum exists in its protoplasm as Dr. Heitzmann says it exists. But that at certain times in certain places within all animal bodies the structure of protoplasm is reticular there can be no doubt. That the reticulum exists at all times and in all places is another matter.

But recently, while I was making a microscopical examination of a sample of urine, a single scale of epithelium appeared under the objective in a drop of the fluid, and was as perfectly and superbly reticulated as could be desired by the most ardent advocate of the theory. The cell had had no treatment except what may have come from its soaking in the urine, yet the net-work of its protoplasm was perfection, and its prominence must have forced itself upon the attention of any microscopist. But thousands of epithelial scales may be studied in as many samples of urine, and not another found in this beautiful condition.

In reference to the common *Amœba*, although I have never yet studied it with the reticulation of its protoplasm in mind, I have recently had the satisfaction of examining a favorable specimen of the allied *Pelomyxa villosa* Leidy, in whose ectosarc the reticulum of the protoplasm was as perfect and as conspicuously marked as in the single epithelial scale just mentioned. *Pelomyxa* is a common Rhizopod in this locality (Trenton, N. J.), but it is usually so gorged with food, with sand grains or with other opaque particles, that its body is almost black by transmitted light, and therefore unsuited for such a purpose as a search for protoplasmic reticulations. But this particular individual was without these obscuring elements, being almost transparent, and fortunately with the protoplasm of the ectosarc so conspicuously reticulated as to obtrude itself upon the microscopist's notice. If the softer and continuously flowing endosarc had been surrounded or enclosed within a delicate net of cords, the reticulations could not have been more apparent or more distinct, becoming even more conspicuous when this external coating flowed out to cover a newly produced pseudopodium. The meshes of this beautiful net were angular, and the living threads that formed them were rather actively contractile, the meshes becoming narrowed and elongated during the animal's movements of progression. The greatest length of perhaps the largest space was, during quiescence, about one six-thousandth of an inch, the smallest being probably about one-third of that size, although careful measurements were not made of either of these.

There can be no doubt that at least at times the ectosarc of *Pelomyxa villosa* is formed of reticulated protoplasm. That it is

always so constituted further investigation should determine. As it is comparatively immense, its examination is not so difficult as is that of the smaller *Amœba*, the study of which, with this special object in view, would demand greater care and an eye trained by practice over the microscopically minute. The subject and the facts are important by reason of their bearings upon the minute examination of objects that may, perhaps, possess a more utilitarian purpose than either the common *Amœba* or the almost equally common *Pelomyxa*.

The examination in this case was made with Bausch & Lomb's homogeneous immersion one-eighth, Reichert's oil-immersion one-twelfth, N. A. 1.40, and Gundlach's homogeneous-immersion one-twentieth, N. A. 1.20.

Trenton, New Jersey.

GLACIATION IN WESTERN MONTANA.

BY HERBERT. R. WOOD.

THE evidences of glaciation in western Montana are very apparent from Helena to Hope (Idaho). They are shown by a series of parallel valleys with a north and south trend, and another series of rounded oblong isolated valleys, connected by narrow necks of land along river bottoms between mountain chains. The former follows the strike of the rocks, occurring along contact lines, synclinal folds, shore or marginal beds of the Sub-Carboniferous formations; the others cross the strike, and, like the former, are also largely the result of pre-glacial denuding forces. The direct evidences are erratic blocks, terminal moraines (frequently holding back lakes), clays, striæ, gravels, etc. The main range of the Rockies (5,550 feet, at Mullan, above the sea), consisting of Devonian, Carboniferous and Sub-Carboniferous, has a valley on the west in the upper Cambrian. Further north-west the glacial striæ run 45° north of west, the general course of valley being 30° north of west.

The elevation at the boundary here is 4,000 feet above the sea; 100 miles south of this it is 3,200 feet, in vicinity of Missoula. From the summit of the main range, as given above, to Hope, Idaho, 300 miles, the fall is over 3,000 feet (5,550 — 2,200). The fall from the boundary is not constant; at Libby, near Idaho, the height is 2,000 feet, forty miles south of this it is 2,500 feet. While the glacial action has been generally from the north, at 100 or 150 miles from the boundary seems to have been the end of the terminal moraines; and a series of glaciers came from the south — the higher elevations of the Bitter Root Range. The great Flathead Valley, which lies west of 114° and extends south from the boundary for 150 miles to Ravalli, is about 30 miles wide. In its southern portion a lake is situated, which is about 35 miles long, dammed by a terminal moraine 200 feet high. The lake is 1,000 feet in depth, its northern shore being a plain, extending for 30 miles, representing an old lake-bed. Another moraine extends across the northern part of this plain, making the boundary line of its northern shore. Such a glacier that could produce this excavation must have been 2,000 feet in thickness and 25 miles wide. Heavy beds of clays, 150 feet in thickness, cover the plain, with a few boulders and thin beds of sand in its lower layers, which is followed by gravels. The worn-down roots of a mountain range are noticeable at both the north and south shores of the lake. This valley runs along the shore line of the lower Cambrian quartzitic series. Some glaciated valleys enter this from the west. The direction of this great glacier seems to have been south-east, crossing a range of mountains 20 miles to the east, which it has left hummocky and worn. Ninety-eight miles west of this the Cabinet Range, 30 to 40 miles long, 7,000 to 10,000 feet high, on the borders of Idaho, shows marked glaciation, the striæ having a course 42° south of west. The height, at Libby on Kooterian, above the sea here is 2,000 feet. The glacial detritus piled along the flanks of this anticlinal is 700 feet in thickness, and represents the material from the gulches. At Hope Pend O'reille Lake the glacial action has undoubtedly been very great, the lake being 2,000 feet deep, with a mountain 4,000 feet above the sea to the north of it. The town is 2,000 above the sea. A number of islands in the lake are scoured down to the water's edge. They represent mountains which may have risen as high as that mentioned. The striations are 40° west of north, 42° west of north. A terminal moraine has dammed the river (Clark's Fork of the Columbia), which enters it from the east, and turned it a mile to the south. Pre-glacial action has been active here and at Libby (see above), some 6,000 feet of strata having been removed from the summit of the Cabinet anticlinal, most of it being pre-glacial denudation. Lake Pend O'reille may perhaps fitly be a glacial lake, a rock basin, which has been filled by the waters of the Columbia. The greatest length of the lake is along the strike of the rocks, though this has not been an important feature in moulding its form, but rather the action of glacier, boulders of diabase and granite being observed several hundred feet above the lake along the mountain side. At Clark's Fork, 20 miles east, I observed granite boulders, on a mountain, at a height of 1,800 feet, or about 4,000 feet above the sea. Heavy beds of gravels, clays, and boulders fall on the valley of the river (Columbia) for 60 miles, the general direction being east and west. At Thompson the glacier has scoured down a range to the south, the path of the glacier being here apparently south-west. A series of terraces extend along the north side of the river, with large blocks of slates (presumably of pre-Cambrian age). At Horse Plains a small valley running east and west represents an old post-glacial lake bed. The glaciers here came from the north, piling up heaps of clays and gravels along the north hummocky side of the valley. One large erratic block of limestone (upper Cambrian) measured $12 \times 15 \times 18$ feet. It was perched about 400 feet above the valley on a diabase dike. This point is 75 miles west of Missoula and about 2,460 feet above the sea. At Missoula a large gravel plain (an old lake-bed), of 40 or 50 miles square, lies in the midst of the lower-Cambrian rocks. To the north the cretaceous rocks dip into the mountains eight miles distant at an angle of 30° north-west. The glaciers have greatly denuded this cretaceous belt into low foothills in their path from the mountains (8,000 feet above the sea) 8 or 10 miles north. Moraines flank the mountains, large blocks of slates and quartzites from the Cambrian rocks resting at the mouths of creeks and stretching across the old lake beds. Around the mountains a series of beaches or beach-lines extend; I have counted 26 of them one above the other, extending upward for nearly 2,000 feet above the plain. These beach-lines I have traced for 50 miles. They seem to represent a pretty general upheaval following upon the close of the cretaceous period. The depth of the gravels which form the old lake-bottoms must be very great. They consist of Cambrian quartzites. To the south of Missoula extends a long valley (terraced) for 75 miles. It lies to the east of a gneissoid range or a bedded quartz porphyry porphroidal or gneiss coeval with Pilot Knob of Missouri and the older Archean gneisses. A glacier undoubtedly travelled to the north, cutting out a range of Cambrian rocks, dipping south, nine miles south of Missoula, connecting it with the old lake previously mentioned. To the north-west of Missoula are several small valleys, through which the Blackfoot River runs. They all run east and west or nearly so across the strike of the rocks, and are divided by low, rounded, hummocky ranges, over which the glaciers have passed. Stratified gravel deposits are exposed along river banks, 75 feet in thickness. One valley, about 12 miles long, running along the strike of the rocks, which dip east, has a moraine at its northerly end made of thickly scattered angular boulders and clays, and of a terrace-like nature, rising 200 feet above the river, which has here cut through it. Ten miles further north another moraine occurs, and five miles further north a great moraine of several hundred feet in thickness and holding ponds and small lakes in its surface. These seem to show, so far as a hasty examination would permit, points in the recession of a great glacier whose course was south-west. A few generalizations from these facts show pretty conclusively that,

1. The rivers are nearly all of pre-glacial origin, but probably post-cretaceous, one or two having been deflected in their courses by the glaciers.

2. The denudation has been largely, if not in greater part, pre-glacial.

3. No apparent upheaval has occurred since the glacial period, but a series of beach-lines indicate a pretty general elevation following the cretaceous period.